

MIDDLE EAR OPERATIONS AS A MEANS OF
IMPROVING THE UTILITY OF THE ORGAN
OF HEARING.

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It is with hesitation that I address this Society upon a subject which has received considerable adverse criticism during the past few years by the majority of those engaged in otological practice. It may be well, by way of introduction, to recall the conditions demanding operative interference and to give a general classification of the various procedures. Measures of this character are employed in two classes of cases. First, those which result from non-suppurative inflammation within the tympanum; second, those which result from an inflammatory process characterized by the formation of pus, and resulting in a certain amount of destruction of the intra-tympanic structures.

With reference to this last class of cases, the subject may be divided into a consideration of operations undertaken while the suppurative process is in progress, and those undertaken to combat results which follow such a process after it has been controlled.

The procedures themselves may be classified as follows:

1. Operations upon the membrana tympani alone, comprising: Perforation of the membrane; Excision of a portion of the membrane; Division of tense fibres within the membrane.

2. *Operations which involve the soft parts within the tympanum*, among which we include: Tenotomy of the



tensor tympani, and stapedius muscles; Synechiotomy, or the division of adhesions; Division of the various ligaments normally found within the middle ear.

3. Operations involving the ossicular chain, including (1) Removal of one or more members of the ossicular chain; (2) Disarticulation at the incudo-stapedial joint; (3) Plastic operations for securing adhesions between the ossicles and the membrana tympani, for the purpose of obtaining certain mechanical advantages.

With reference to the operations mentioned in the first two groups, that known as synechiotomy, or the division of adhesions, will alone receive attention. A simple perforation of the drum-membrane, or the excision of a portion of this structure for the purpose of securing a permanent opening into the tympanic cavity, has seldom effected a permanent improvement, although the operation is frequently followed by a temporary increase in hearing.

Section of the various intra-tympanic muscles and ligaments, in cases of non-suppurative inflammation, has also met with but moderate success, for the reason that, although the various muscular or ligamentous structures may have been the principal seat of the inflammatory process, and by their abnormal tension may have led to certain functional defects, the pathological changes have not been confined to these ligamentous and muscular structures alone, but have involved other parts in the tympanic cavity, and these operative procedures have been followed by but temporary benefit, on account of the steady progress of the inflammatory process elsewhere.

Special attention will be directed in this paper to the results obtained by the division of intra-tympanic adhesions, and by the removal of such portions of the conducting mechanism as may obstruct the transmission of

sound impulses, or by their presence may favor a re-development of adhesions and prevent free access to the middle ear for future operative procedures. In this way we most perfectly eliminate anomalies in tension, by removing all the parts affected, the procedure leaving the tympanic cavity in such a condition that any adhesions which may develop subsequently will be directly under ocular inspection and easily accessible to surgical interference.

Regarding the probable effects of intra-tympanic operations upon the function of audition, it must be remembered that although anomalies in tension may be present in a given case, they need not constitute the sole, or even the most important, cause of impairment of function. In other words, it is necessary in every case to establish the integrity of the perceptive mechanism before any treatment of the transmitting apparatus can be efficient.

A careful reading of the history of many cases, and personal examination of not a few, has convinced me that the failure to establish with certainty the exact location of the cause of the defect in hearing, is responsible for the unfavorable opinion so frequently expressed regarding the utility of middle ear operations. It is not out of place, therefore, to state briefly the means employed in the following cases to locate the cause of impaired function in the conducting apparatus, and to show that the perceptive system was intact, or sufficiently so to perform its function with a fair degree of integrity.

Without entering into a discussion of physiological experiments which are familiar to all of you, I will simply recall the fact that when anomalies of tension are present in the conducting mechanism, such as relaxation of the membrana tympani, or of the intra-tympanic ligaments, or when there is increased tension of the membrane itself or

in the ossicular chain from the development of adhesions between the ossicles themselves or between them and the tympanic walls, the tension anomaly is characterized by a failure to perceive the lowest notes of the musical scale. As the conducting mechanism becomes more weighted, the defect in audition rises higher in the musical scale. A determination of the lower tone limit, therefore, affords us a measure of the degree of tension anomaly present, the greater the variation from the normal standard, the higher the lower tone limit. At the same time, as sounds are poorly perceived through normal channels or by air conduction, their vibrations conducted to the labyrinth through the solid media of the skull are better perceived than under normal conditions. In other words, bone conduction is either increased absolutely, or absolute bone conduction is normal, but the ratio between bone and air conduction is reversed. For making this test, a tuning-fork making two hundred fifty-six double vibrations a second has been used.

If, now, the labyrinth has become involved secondarily, the part first attacked is the lower turn, which lies in immediate proximity to the tympanum and which is concerned in the perception of the highest notes of the musical scale. This is true in a very large proportion of cases, and is recognized by a reduction in the upper tone limit. Coincident with this defect in the upper portion of the musical register, sounds are poorly perceived through the solid media of the skull, or bone conduction is reduced, the ratio of air to bone conduction being preserved. If, then, in a given case we find that the hearing is impaired, while functional examination reveals an elevation of the lower tone limit and an increase in bone conduction, while the upper tone limit is either normal or but slightly lowered, we are warranted in locating the pathological

condition in the conducting mechanism. Having excluded any pathological condition in the meatus by ocular inspection, and by the same means discovered abnormal conditions within the middle ear, due either to suppuration or to hyperplasia, we should naturally direct our treatment toward this part. It seems hardly necessary to state that this treatment will not be operative, unless all other measures have failed. I make this statement for the reason that many seem to believe that one who advocates operation in any case advocates indiscriminate operation. I cannot emphasize too strongly the fact that surgical measures are to be adopted only in cases where less radical means have been unsuccessful.

On the other hand, it is the duty of the surgeon to give the patient every possible chance of improvement, and, other measures having failed, surgical interference should not be delayed.

The preceding observations apply equally well to non-suppurative affections, and to those in which the condition is due to a previous destructive inflammation.

We next come to the technique of the various surgical procedures. The opinion has been prevalent that these operations should be conducted only under general anæsthesia. For the last year it has been my invariable practice to employ local anæsthesia in cases operated upon to improve the function of the ear, whether there had been extensive destruction of the membrana tympani, or where this was intact. Fortunately but few of the non-suppurative cases are met with in patients who have not reached adult life, and among these I have never found one who could not easily submit to the necessary manipulations without general anæsthesia. Blake has pointed out that the sensibility of the membrana tympani is comparatively slight in the posterior segment near its periph-

eral attachment, and there is abundant clinical proof to confirm this. After the tympanum has once been entered, the introduction of cocaine into the cavity produces perfect anæsthesia, and prolonged manipulation can be carried out without disturbing the patient. Where the drum-membrane has been largely destroyed, the local anæsthetic can be applied directly to the mucous membrane of the tympanum, rendering all manipulation painless.

Where a large opening exists in the drum-membrane and we have determined that the impairment of hearing is due to some tension anomaly in the conducting mechanism, our operative procedure consists in freeing the ossicular chain by incising tense bands running from the ossicles to the tympanic walls, or by disarticulating the stapes from the incus, and dividing adhesions between this ossicle and the walls of the pelvis ovalis, severing the stapedius muscle if necessary, and subsequently increasing the mobility of the stapes by breaking up any remaining adhesions by passive motion with a probe. The exact technique will be detailed in describing the procedure in non-suppurative cases.

Remembering that sound perception is effected by the transmutation of aerial vibrations into a similar mode of motion in a column of fluid, and bearing in mind that fluids are practically incompressible, it is not sufficient that the stapes shall be free, but it is also essential that the membrane of the round window shall be able to perform compensatory excursions. When, therefore, in the region of the round window the mucous membrane is found thickened, stellate incisions in this region relieve the tension of the labyrinthine fluid, and an inward motion of the stapes in response to aerial condensation due to sonorous vibrations becomes possible. Cases of impairment of hearing

following a suppurative otitis media usually present unmistakable evidences of variation from the normal standard, and but little doubt can exist as to the particular operative procedure demanded, and these measures may be embraced under the general term of synechiotomy, disarticulation of the stapes, and mechanical mobilization. In certain instances the two larger ossicles, together with the remnant of the membrana tympani, may demand removal to prevent a recurrence of the condition. On the other hand, where suppuration is still active, the excision of these ossicles may seem advisable for the relief of this condition; the effect, however, to be expected upon the function of the organ is to be determined by the principles already laid down.

When we come to non-suppurative cases the exact technique is of more importance, and will be entered into in detail. Speaking broadly, the removal of the membrana tympani, malleus, and incus should be considered as a preliminary step for the purpose of rendering the region of the oval and round windows easily accessible to surgical interference, both at the time of operation and during the period of convalescence.

The preparation of the field of operation in all cases is as follows: The external auditory meatus is thoroughly cleansed by syringing with an aqueous solution of bichloride of mercury of the strength of 1-4000, after which the entire canal, including the membrana tympani, or what remains of it, is thoroughly brushed with a solution of the bichloride of mercury 1-3000 in equal parts of alcohol and water. Careful attention to this latter point is of great importance, since we find almost invariably certain low forms of vegetable life present in the meatus which seriously interfere with the progress of the case after operation. These measures of

cleansing are best carried out on the day before the operation, the meatus being subsequently plugged with a pledget of sterilized cotton; at the time of operation, this is removed and the parts again brushed with the alcoholic sublimate solution.

The first step of the operation is the formation of a flap in the posterior quadrant to expose the incudo-stapedial articulation and the round window. A pointed, straight knife is introduced into the meatus, incising the membrane for about two millimeters either upward or downward at about the middle of the posterior border, just within the clear membrane and following the line of attachment. If sufficient attention is given to the condition of the knife, this puncture is absolutely painless. The margins of the wound are next touched with a ten per cent. solution of cocaine, previously sterilized by heat, the application being made by a delicate cotton-tipped probe. This incision is next extended upward along the periphery of the membrane with the probe-pointed knife, the operator stopping from time to time whenever the patient indicates that the area of anæsthesia has been passed. This exploratory incision extends upward to the posterior fold, when the direction is changed, the knife being carried parallel to and just below this fold, to avoid hemorrhage, as far as the manubrium mallei, where the direction is again changed and the knife carried downward parallel to the manubrium, and far enough behind it to avoid the vessels of the manubrial plexus. A large flap is thus formed which can be turned downward, after which the mucous membrane of the tympanum is open for inspection. In very many cases the incudo-stapedial articulation can be seen without difficulty, but quite frequently it lies so close to the tympanic ring that any manipulation is difficult.

The next step should be to divide the stapedius muscle

by passing a straight sharp-pointed knife inward between the head of the stapes and the tympanic ring until the point is felt to impinge upon the internal bony wall of the tympanum. The knife is then carried downward until it lies below the level of the head of the stapes, dividing everything in its path. This effects the division of the stapedius muscle and of adhesions disposed in this portion of the cavity. An additional advantage gained by this incision is that the incudo-stapedial articulation is brought more clearly into view on account of the unopposed pull of the tensor tympani muscle. Quite frequently I have observed the articulation move at least a millimeter from the tympanic ring after this step had been taken.

We next divide the incudo-stapedial articulation by passing an angular knife in front of the long process of the incus, and severing the joint by pressing the instrument downward and backward. In this way we make use of the resistance of the tensor tympani muscle, and are in no danger of injuring the delicate structures by too much force. It may be necessary, on account of the peculiar position of the parts, to introduce the knife from behind, between the long arm of the incus and the tympanic ring, in which case a little care is necessary, in order that the stapes may not be disturbed unduly. It will be remembered that the articulation does not correspond to the right angle at the lower extremity of the long arm of the incus, but that the tip of the long arm of the incus bends inward upon itself at a right angle. The articulation lies upon nearly the same plane as the internal wall of the tympanum, and the angular knife should be carried well inward until the flat surface of the blade lies in contact with the osseous tympanic wall, when pressure downward causes the blade to enter the joint and effect disarticulation. It may be more simple to open the joint from below upward in certain cases.

If no improvement follows the opening of the tympanum and disarticulation of the stapes, and mechanical mobilization and the division of adhesions about the niche of the round window, the operator may, if he chooses, replace the flap, cover the entire site of the operation with a paper dressing, as advised by Blake, and allow the case to proceed without further operative interference.

If improvement is evident, we should remove the membrana tympani, malleus, and incus. After introducing cocaine into the tympanic cavity upon a probe through the large posterior opening, the membrana tympani is incised in a horizontal direction at its lower pole, just within the clear membrane. This incision is only of sufficient length to admit the probe-pointed knife. This instrument is then introduced and the anterior attachment of the membrane severed as far as the anterior fold. The knife is then turned in the opposite direction and the posterior attachment divided from the lower pole to the site of the original exploratory puncture. Any adhesions existing between the manubrium and the internal tympanic wall are separated with an angular knife. After thoroughly anæsthetizing the upper portion of the tympanic cavity with cocaine, applied upon a cotton-tipped probe, the cotton pledget being wound firmly and bent at a right angle so that it can be passed beneath the anterior and posterior folds so that we can effect thorough anæsthesia, that portion of the membrane above the axis band is severed either by the blunt or sharp pointed knife, as may seem advisable. If the former instrument is used, it is introduced beneath the posterior fold, with the edge directed upward, and all the soft parts divided until the incision has reached a point directly above the short process of the malleus. In the same manner the tissues above the anterior fold are divided, and the peripheral

attachment of the membrane is completely severed. The malleus is now held in place by the superior ligament and some bands of the external ligament. If not freely movable upon touching it with the probe, the sharp straight knife is introduced above the short process and pushed upward and inward into the vault, the edge being directed at first backward and then forward to effect the division of any remaining bands. The malleus is now grasped by the forceps at the short process and is pressed first inward, then pulled downward, and finally extracted from the canal, the procedure giving but trifling pain, and, in many instances, none at all. Frequently the removal of the malleus displaces the incus so that its long process can be seen projecting into the tympanum sufficiently to permit of its being grasped by the forceps and immediately extracted. It lies either in the superior-posterior quadrant, or (as is frequently the case) well down along the posterior periphery of the ring. Where the long process does not protrude sufficiently to allow the forceps to grasp it, or where it cannot be seen, the incus hook is to be introduced low down in the tympanic cavity, the concavity of the hook being directed upward. This instrument is passed behind the tympanic ring in the postero-inferior quadrant, and is swept upward toward the superior pole, while at the same time it is rotated upon its long axis, so that its concavity sweeps the posterior tympanic space. The hook is to be so held that its angular portion lies close to the tympanic ring, as the long process of the incus is most frequently found in this situation.

If a little care is used, there is no danger of engaging the stapes, and, in fact, it is difficult to do this even if we desire to do so. It may be necessary to repeat these manipulations a few times before the long process is brought into view sufficiently, but failure is practically

impossible. When the long process can be seen, it is grasped by the forceps and the ossicle removed. After thoroughly drying the cavity by means of pledgets of cotton, the condition of the stapes is investigated, and, if it is not movable when touched with a cotton-tipped probe, the sharp-pointed knife is passed between the posterior crus and the opposite wall of the niche, dividing any adhesions, the procedure being successively repeated along the posterior, the anterior, and superior aspects of the pelvis. The cotton-tipped probe is then applied to the stapes between the inferior wall of the pelvis ovalis and the ossicle, and gentle pressure employed in an upward direction; the same procedure is repeated posteriorly, superiorly, and anteriorly, care being taken not to employ sufficient force to rupture the crura.

As soon as the ossicle is mobilized, the niche of the round window is examined and any tense bands divided by introducing an angular knife between the tympanic ring and the margin of the niche, the edge of the knife being pressed against the thickened tissue by rotating the instrument upon its long axis. The parts should now be thoroughly dried, the canal cleansed with the alcoholic sublimate solution and a cotton wick carried into the tympanum, its extremity being coiled up just within the entrance of the meatus; the orifice of the meatus is occluded with a pledget of sterilized cotton. This cotton drain prevents the formation of a fibrinous clot within the tympanum, and renders the first dressing less painful than if it is not employed. Considerable oozing usually takes place from the divided structures, and the patient is directed to change the outer plug as frequently as may be necessary, the drain being so deeply situated that it cannot be removed by accident. There is a moderate amount of pain for the first two hours following the operation,

seldom enough to disturb the rest at night, and as a rule the patient is able to follow his usual vocation upon the following day. In exceptional cases there is considerable giddiness, and sometimes vomiting immediately after the operation, but even here the constitutional disturbance passes away in a few hours. The cotton drain is removed about twenty-four hours after the operation, the parts cleansed with sterilized cotton, and the meatus occluded by a plug of the same material, although it is not necessary to introduce a drain into the tympanum. Aside from keeping the meatus aseptic no local treatment is required.

At the end of four or five days the patient is allowed to remove the cotton while indoors, replacing it when in the air. At the end of ten days the parts no longer need protection. Where there is considerable serous discharge it may be necessary to apply a solution of alcohol and corrosive sublimate to the mucous membrane of the middle ear, while in other cases a little boric acid is dusted over the parts. The rule, however, should be to interfere as little as possible with the tympanum, as any mechanical irritation favors the reproduction of the membrana tympani.

Much adverse criticism has been met concerning the results obtained by surgical procedures within the tympanum; it should be remembered that these are considered measures of last resort, and that in many cases years have elapsed since the beginning of the disease and the surgeon is consulted so late that but very slight improvement can be expected. We should not compare the results obtained after these operations with the functional condition of a normal ear, but rather with that of the affected organ before any such procedure was instituted. Another fact to be remembered is, that in the application of tests, errors are likely to arise; since the

increased weight upon the conducting mechanism interferes especially with the transmission of the lower notes of the register, the marked impairment in these cases consists in an inability to perceive the human voice and to understand conversation readily. Tests with the voice, therefore, either whispered speech or the conversational tone, are the most valuable in determining the amount of improvement after operation. It is even possible that the hearing for sharp sounds, such as the sound of the acoumeter, or the tick of the watch, may be no better, or that it may be even less acute than before operation, while at the same time the ability to understand conversation is markedly increased. This is easily explainable if we recall certain physical laws. It will be remembered that Helmholtz has proved mathematically that for the lower notes of the register the several ossicles may be considered as single particles, since their dimensions are infinitesimal as compared with the wave length of the note which is transmitted. When, however, we approach the upper tone limit of audition, the mass of the various members of the ossicular chain becomes commensurate with the wave length of the note. In other words, the longest linear measurement of the malleus or of the incus equals very nearly the wave length of the note in question. Under these conditions, molecular vibrations within the ossicles must be considered, and the more fixed the ossicular chain becomes, if an anomaly in tension is present, the more easily are these high notes transmitted through the chain, the entire ossicular chain constituting a rigid or a solid body, and obeying the laws of such bodies. If, then, we have an increase of tension above the normal standard, but not sufficient to allow the ossicular chain to constitute an immovable mass of matter, this variation may cause an actual diminution in the perceptive

power for sharp noises, such as the click of the acoumeter or the tick of the watch.

In the results reported, the human voice has been taken as the standard, the estimate being made as carefully as possible both for the conversational voice and for whispered words. I need scarcely say that test sentences and test numbers have been so chosen in comparing the power of audition before and after operation as not to represent the highest degree of hearing obtainable if special sentences were chosen. Nor, on the other hand, does it represent the minimum, as if the test were made with those words understood only with great difficulty. In many instances the patient's own statement as to the improved condition has been taken into consideration. In several cases patients have been able to continue an occupation which otherwise must have been given up had not considerable improvement followed treatment.

Another fact which must be taken into consideration is the effect which any procedure directed to one organ of audition exerts upon its fellow of the opposite side. So much has been written within the last few years upon "*aural sympathy*" that the fact needs only to be mentioned and demonstration would be superfluous. Some observers—notably, Cholewa—advocate operative procedures upon an ear which is totally deaf, for the beneficial action which may be exerted upon the organ of the opposite side. In many of my own cases, a marked improvement has been observed in the ear not operated upon, or, in other words, the general functional improvement has been greater than could be accounted for by the improvement upon the side operated upon. This may be explained upon the hypothesis that marked inequality in audition upon the opposite sides would interfere more with the integrity of hearing than the total ablation of function

upon one side. In many cases, however, this explanation does not account for the improvement, and we must admit that actual increase of functional activity in one ear may follow an operation upon the other. This seems best explained upon the hypothesis that most of the fibres of the auditory nerve which terminate in the cochlea of one side cross to the opposite side of the brain in the corpora trapezoidea and pass to the cortical perceptive centre of this side, while a few pass to the receptive centre of the corresponding side of the cerebrum. Any irritation of the peripheral endorgan of this nerve exerts an action upon the centre, which in turn impairs stimuli reaching the centre from the opposite ear, which is its chief peripheral termination. In other words, we remove the inhibitory action of the ear most affected, and consequently improve the function of its fellow.

As regards serious complications of an inflammatory character following such operations, I would say that it has never fallen to my lot to observe them in my own practice; in but one instance has the reaction been severe, and here the complication was simply a diffuse external otitis which never became sufficiently serious to keep the patient in bed.

The disturbance of equilibrium which sometimes follows interference with the stapes was severe in one instance, in a man over sixty years of age, and in this case the power of audition seemed to be entirely destroyed by the operation. I can explain this only by supposing that a labyrinthine hemorrhage occurred. This supposition is the more warrantable as there was extensive calcification of the arteries. A few months later the patient suffered from what was apparently a small localized cerebral hemorrhage.

The permanency of the results obtained has not been

determined definitely, as a sufficient time has not elapsed since the operation, in many cases, but in all where a sufficient time has passed the results have been eminently satisfactory.

Concerning the reproduction of the tympanic membrane, in some instances this has not occurred at all; in others, the membrane has reformed either immediately, or after several months, as the result of a sub-acute inflammation of the tympanum and upper air tract. In these cases the removal of this membrane is extremely simple. The operator, however, should wait until all traces of congestion have disappeared and the membrane has become thin and parchment-like. It may then be removed without pain, and either extracted, or, in some cases, the delicate lamella is allowed to collapse and lie in the canal, the vascular supply being so poor, on account of the small pedicle by which it is attached, that it disappears in a short time. In removing such a membrane, prolonged manipulation is to be avoided, as all such measures favor the reproduction. The membrane may even reform a second or third time, but the treatment is so simple that it can scarcely be looked upon as a matter of any great moment.

The danger of leaving the tympanic cavity exposed to the air has in no instance been demonstrated in my own practice. Occasionally in individuals who are particularly prone to acute congestion of the upper air passages, a severe cold in the head may be followed by slight serous discharge from the ear lasting a few days. If the parts are kept thoroughly cleansed and vegetable parasites prevented from taking root in the canal, no unpleasant complications follow. It is well in such a condition to occlude the meatus if the discharge is not profuse, and to wipe it out thoroughly daily, or every second day, with

an alcoholic solution of the corrosive sublimate, to prevent the development of vegetable parasites. If the patient is at a distance, he may syringe the ear with a mild antiseptic lotion once or twice daily, to accomplish the same result.

I append a brief resume of the results obtained in operations of this character. In cases where the membrana tympani was intact, including one or two instances where there had been a suppurative process in childhood, with complete closure of the perforation, eighteen cases have been subjected to operation under cocaine anæsthesia. Of these there was great improvement in ten cases, with a slight relapse in one case; there was a moderate amount of improvement in seven, with a relapse in one instance; and in one case—a female of neurotic temperament—the improvement was but slight.

In thirteen cases of this character operated upon under ether, two were greatly improved, five much improved, five slightly improved, and in the remaining case the condition remained the same as before operation.

In eleven cases the condition was due to a previous purulent inflammation, which had resulted either in a slight or extensive destruction of the membrana tympani, the perforation persisting. The operative procedures were confined to freeing the stapes and mobilizing it as described in the preceding pages, without resort to general anæsthesia. Of these there was great improvement in one, the whispering distance increasing after operation from twelve inches to fifteen feet, and the degree of improvement being maintained at the time of the last examination, which was about six weeks after operation; in ten there was decided improvement, although not as great as in the case just mentioned. Of the eleven cases, disagreeable symptoms followed the operation in but one instance.

In ten cases there was a purulent otitis in which the operation was performed both for the relief of the otorrhœa and, at the same time, to improve the hearing. Of these there was great improvement in five; moderate improvement in three; while in two the function of the organ remained the same as before operation.

In ten cases the membrana was intact, and the stapes was removed or the crura fractured in the attempt at removal, the operation being done with cocaine. In most instances the removal of the incus was necessary, in order to gain access to the stapes. Of this number three were improved; two were much improved; one slightly improved; two unimproved; and two were made worse. In one case where much improvement followed the operation a relapse took place at a later period, although the hearing still remained better than before the operation.

It was found in quite a number of these cases of stapedectomy that the improvement became much less after the perforation in the membrana tympani closed, and in these instances the malleus and membrana tympani were removed at a later period, in order to secure a permanent opening into the tympanic cavity. This procedure was followed by improvement in all the cases. In one instance, synechiotomy was practiced for the improvement of hearing before the purulent discharge had ceased entirely, this being so moderate in amount as scarcely to warrant general anæsthesia and the removal of the entire ossicular chain; slight improvement followed the procedure in this instance.

It will be seen from these statistics that the greatest improvement has followed those operations performed under cocaine anæsthesia, and where the design has been to secure a permanent opening into the tympanum. This seems to be the most rational procedure in all cases even

where the membrana tympani is intact, and since it can be done without general anæsthesia we are certainly warranted in recommending at least an exploratory tympanotomy in all cases where the hearing has failed to improve under less radical measures. In no given case can we state the amount of improvement which we should expect, and it is always our duty to inform the patient of the experimental character of the measure. From the fact, however, that the procedure is followed by no discomfort, that it can be performed without pain, and that it, humanly speaking, will not injure the organ, we certainly fail to fulfill our entire duty to our patients if the subject is not presented to them fairly.

At a period when it was thought necessary to resort to general anæsthesia, the question of the administration of an anæsthetic was quite a prominent factor, and in many instances we might not feel warranted in advising the patient to submit to this, on account of the extreme doubtfulness of the result which we might hope to obtain from the operation. Moreover, the ability to test the hearing at different periods during the operation is of great value, as it allows us to estimate the amount of benefit obtained at each successive step, and prevents us from being too zealous in our work.

With regard to those cases operated upon primarily for the relief of the discharge, only a few have been included in this paper, as we are dealing with operations for the improvement of function. In a previous article on this subject (*Supplement to the Reference Hand Book of the Medical Sciences*), out of twenty-nine cases of this character operated upon by the author for the relief of a purulent discharge, in but one was the hearing worse than before the operation, and it was possible here that the impairment was simulated. Up to the present time my

own cases of this character number fifty, with but one single case of impairment to the function after operation. Ludwig found the hearing worse after operation in six out of seventy-five cases operated upon, so that we can state usually that there is no danger of impairing the hearing if we operate for the relief of the discharge alone.

Concerning the operation for the removal of the stapes, the subject has been already discussed before the Society, and many of the cases followed for a period of two years after the operation. It seems that the procedure is fairly successful in cases where the condition has resulted from a previous purulent inflammation, and in one case of the kind, not included in the present report, the improvement was very marked, and has remained so. In general, however, we may say that both in the purulent and in the non-purulent cases, mechanical mobilization of the ossicle gives better results than its extraction.

